Geometric Uncertainty in U.S. Coast Survey T-Sheet T1432b (1876)

Missing Survey Documentation, Later Geodetic Reference Annotations, and Sources of Geometric Uncertainty, with Implications for Ballona Wetlands Reconstruction

Draft Version 3.25

Executive Summary

U.S. Coast Survey T-Sheet T1432b (1876), entitled West Beach to Vicinity of Santa Monica, is one of the principal historical maps used in reconstructing the nineteenth-century Ballona Wetlands. Despite its importance, repeated attempts to register the sheet accurately within a modern geographic coordinate system have produced inconsistent results.

Five locations on the surviving sheet bear later hand-drawn geodetic-style markings — hatched triangular symbols at four locations and a cross symbol at a fifth — together with handwritten references to the "North American Datum" and associated angular or coordinate values. These are not part of the original 1876 engraving.

This report examines the problem as one of historical geography, cartography, geodesy, and spatial registration, rather than simply one of datum conversion. The available evidence indicates that uncertainty arises from a combination of incomplete archival documentation, historical Coast Survey mapping practices, the well-documented discrepancy between successive North American geodetic datums, possible non-rigid deformation of the surviving sheet, and the inherent challenges of nineteenth-century marsh mapping.

The objective of this report is not to conclude that the mapped wetlands are geometrically incorrect, but rather to identify the sources of uncertainty and establish appropriate limits on the interpretation of the sheet.

1. Introduction

T-Sheet T1432b, surveyed in 1876, represents one of the earliest detailed depictions of the Ballona Wetlands and adjacent Santa Monica shoreline.

Because the sheet predates virtually all twentieth-century development, it has become a foundational historical source for ecological reconstruction, shoreline studies, and environmental planning.

However, attempts to register the map accurately within modern coordinate systems such as NAD83, California State Plane, or Web Mercator have consistently encountered significant difficulties.

In this report, "registration" refers to the process of transforming the historical sheet into a modern spatial reference system so that its mapped features can be compared against, or overlaid upon, known present-day coordinates.

This report addresses horizontal (geometric) uncertainty only. Vertical or elevational information, where used elsewhere in Ballona Wetlands analysis, is subject to separate datum and benchmark considerations and is not treated here.

The central question is therefore not simply "What datum was used?" but rather:

Why does this historically important map resist reliable modern georegistration?

2. The Registration Problem

Five locations distributed across the sheet contain later handwritten annotations in a hand and ink distinct from the engraved 1876 map text and symbology. Four are marked with hatched triangular symbols; one is marked with a cross. Each is accompanied by a handwritten reference to the "North American Datum," in most cases qualified "(1927)," together with an angular or coordinate value.

Because these markings postdate the original survey and are not part of it, this report refers to them as later geodetic reference annotations rather than as "datum points" or original survey control — a distinction maintained throughout, since their precise function has not been independently documented.

Table 1 summarizes the location, symbol, and transcribed content of each annotation, based on close visual examination of a high-resolution native scan of the sheet.[1]

#	Location	Symbol	Color	Transcribed Text	Legibility
1	North edge, near "Centinela"	Hatched triangle	Blue	"North American (1927) Datum," "J.F.-33" (surveyor initials and year, pending independent confirmation)	Substantially legible
2	Western marsh (mid-left)	Hatched triangle	Blue	"North American (1927) Datum," "J.F.-33," 34°00', 118°26'	Clearly legible
3	"Level Grassy Plain" (mid-right)	Hatched triangle	Blue	"North American (1927) Datum," "J.F.-33," 33°56', 118°24'	Substantially legible
4	Southwest, bottom edge	Hatched triangle	Red/maroon	34°00', "North American datum," "H.B., 1913"	Substantially legible
5	Southeast, bottom edge	Cross (not a triangle)	Graphite (pencil)	"North American datum," 33°52', 118°25' (no surveyor initials or year; medium is graphite pencil, not ink)	Clearly legible

Table 1. Later geodetic reference annotations on T1432b.[2]

Registration attempts by multiple independent researchers, including this report's author, over approximately the past ten years indicate that the sheet has not yet been successfully transformed into modern coordinates using a single rigid mathematical transformation that simultaneously

[1]Corresponding source images archived with the project records: Annotation_1_top_Centinela.jpg; Annotation_2_midleft_marsh.jpg; Annotation_3_midright_grassyplain.jpg; Annotation_4_bottomleft.jpg; Annotation_5_bottomright.jpg.

[2]Transcriptions are based on close visual examination of high-resolution scans of the sheet; two abbreviations and one numeral were initially unconfirmed; direct examination of higher-resolution scans has since resolved all three, as reflected in the current transcriptions above and discussed in Section 6.2.

preserves all mapped features. This observation raises several possibilities, none of which can presently be distinguished uniquely from the surviving evidence:

- the original 1876 reference frame is incompletely documented,
- the later annotations do not represent primary survey control,
- the surviving sheet has undergone non-uniform physical deformation,
- portions of the map were compiled using different surveying methods,
- or multiple effects are acting simultaneously.

At present, the available evidence does not uniquely distinguish among these possibilities.

It is also possible that registration attempts fail not because no transformation can be computed, but because different candidate transformations may fit different portions of the sheet unevenly (e.g., coastal versus marsh regions) — a hypothesis that has not yet been systematically tested and is noted here as a candidate explanation rather than an established finding.

3. NOAA Assessment of the Historical Record

Correspondence with the National Oceanic and Atmospheric Administration provides critical historical context.

In an email dated April 20, 2021, a representative of NOAA's Remote Sensing Division stated that a Descriptive Report was not written for T-T01432B (1876); the first Descriptive Report requirement dates to April 11, 1887, postdating this survey.[3]

This statement has several important consequences. First, the absence of supporting documentation is not the result of lost records. Instead, the documentation commonly associated with later Coast Survey topographic sheets was never required for T1432b.

Consequently, no official record has been located describing:

- survey control,
- benchmark locations,
- projection methods,
- field procedures,
- mapping methodology,
- station descriptions,
- or coordinate reductions.

The absence of these records substantially limits the ability to reconstruct the original survey framework.

4. Historical Coast Survey Marsh Mapping

[3]NOAA, National Ocean Service, Office of Coast Survey, Remote Sensing Division, email correspondence, April 20, 2021 (on file).

NOAA further cited guidance summarized in Aaron L. Shalowitz's Shore and Sea Boundaries, describing nineteenth-century Coast Survey practice.[4]

The historical guidance indicates that marsh boundaries were not always mapped entirely through chained measurements. Instead, surveyors frequently established measured control points and then completed portions of marsh boundaries through visual interpretation between those controls when direct measurement proved impractical.

NOAA also noted that adjoining nineteenth-century marsh surveys often differed in their representation of the same shoreline. This historical observation is particularly significant because it demonstrates that variability in marsh depiction was recognized by Coast Survey personnel themselves.

Accordingly, minor geometric inconsistencies within marsh interiors should not automatically be interpreted as surveying errors, but neither should they be assumed to possess engineering-grade positional accuracy.

A more recent, independent examination of T1432b itself provides additional context. Grossinger et al. (2011), in a regional atlas of Southern California T-sheets, discuss T1432b specifically, identifying its surveyor as A. W. Chase and noting: "For unknown reasons, this map was produced at a scale of 1:20,000, substantially smaller than most other Southern California T-sheets (which were mapped at 1:10,000)." This observation is independent of the registration questions addressed in this report but provides useful historical context regarding the map itself.[5]

5. Missing Archival Documentation

Inquiries were made to NOAA, the National Archives, and the United States Geological Survey concerning supporting documentation associated with T1432b.

Despite these inquiries, no Descriptive Report, survey metadata, field books, station descriptions, ship logs, triangulation records, or equivalent documentation sufficient to reconstruct the original survey reference frame has been identified.

As a result, the surviving T-Sheet must presently be treated as an historical cartographic artifact whose supporting geodetic documentation is unavailable. Consequently, any modern spatial interpretation necessarily relies upon indirect reconstruction rather than documented survey parameters.

NOAA's Historical Shoreline Survey Viewer typically distributes a shoreline survey with its scan, world file, shoreline vectors, and, where available, a Descriptive Report; only about 7,800 of NOAA's 16,200 total T-sheet and TP-sheet scans have been georeferenced this way, with no plans

[4]Shalowitz, A. L., Shore and Sea Boundaries, Volume Two: Interpretation and Use of Coast and Geodetic Survey Data, U.S. Coast and Geodetic Survey Publication 10-1 (Washington, D.C.: U.S. Government Printing Office, 1964).

[5]Grossinger, R.M., E.D. Stein, K.N. Cayce, R.A. Askevold, S. Dark, and A.A. Whipple. 2011. Historical Wetlands of the Southern California Coast: An Atlas of US Coast Survey T-sheets, 1851–1889. San Francisco Estuary Institute Contribution #586 / Southern California Coastal Water Research Project Technical Report #589. T1432b is discussed at pp. 20–23; the surveyor identification and scale quotation in Section 4 are drawn from p. 20. Figure 18 (p. 23), captioned "Coastal features digitized from T-1432b, overlaid on modern aerial photography (USDA 2005), at same scale as facing T-sheet," is the source of the georeferenced base layer referenced in Section 7.

to complete the rest, and whether T1432b is among them remains unconfirmed (see Section 8).[6] In any event, the Descriptive Report ordinarily included in such a package is, as established in Section 3, unavailable for this sheet.

A related archival record bears on this sheet's subsequent history. Following the 1876 Chase survey, the U.S. Coast and Geodetic Survey conducted a further survey of this area in 1887, under Surveyor Ferdinand Westdahl, prompted by proposed harbor development at Ballona. Grossinger et al. (2011) report that this resurvey "mostly reproduces the earlier survey, while focusing on changes resulting from dredging at the channel mouth associated with jetty construction," quoting Westdahl's own account that "the channel between the jetties, instead of scouring as it was expected to do, filled up so as to leave but a narrow channel at low water."[7] The 1887 resurvey constitutes a separate, documented survey epoch in this sheet's lineage, distinct from the five later annotations discussed in Table 1 and Section 6, which reference datums postdating 1887 by decades. Whether the 1887 resurvey survives in a form suitable for direct geometric comparison with T1432b's original 1876 state is addressed in Section 8.

6. Sources of Geometric Uncertainty

Several independent mechanisms may contribute to the observed registration difficulties. They are separated below into a known, quantifiable effect and two effects that remain undetermined, since conflating them overstates what is presently known.

6.1 Known Effect: Datum Succession (1901 → 1913 → 1927 → 1983)

The U.S. Coast and Geodetic Survey adopted a national horizontal datum in 1901 (the U.S. Standard Datum, on the Clarke 1866 spheroid). In 1913, following adoption of the same reference frame by Canada and Mexico, it was renamed the North American Datum. As additional triangulation data accumulated, it was recomputed — same spheroid, same origin — as the North American Datum of 1927 (NAD27).[8]

Three of the five annotations on T1432b explicitly cite “North American (1927) Datum”; a fourth cites “North American datum” together with a “1913” reference; a fifth cites “North American datum” with no year specified at all. Section 6.2 discusses these differences in detail, including newly identified surveyor-initial notations that distinguish at least two of these annotation groups from one another and from the fifth. This report treats the annotations as more plausibly representing at least two, and possibly three, distinct historical episodes than a single undifferentiated later addition, though it does not yet conclusively establish how many episodes are represented or precisely when each occurred.

[6]NOAA, National Ocean Service, National Geodetic Survey Information Center, email correspondence, April 9, 2021 (on file); NOAA Office of Coast Survey, “Historical Surveys (T-Sheets),” https://shoreline.noaa.gov/data/datasheets/t-sheets.html (accessed 2026).

[7]Grossinger, R.M., E.D. Stein, K.N. Cayce, R.A. Askevold, S. Dark, and A.A. Whipple. 2011. Historical Wetlands of the Southern California Coast: An Atlas of US Coast Survey T-sheets, 1851–1889. San Francisco Estuary Institute Contribution #586 / Southern California Coastal Water Research Project Technical Report #589, p. 20, discussing the 1887 U.S. Coast and Geodetic Survey resurvey conducted by Ferdinand Westdahl in connection with proposed harbor development at Ballona, including his account of the dredged channel's post-construction behavior.

[8]National Geodetic Survey, “History of the North American Datum,” NOAA/NOS geodesy history reference; National Geodetic Survey, NADCON (North American Datum Conversion) documentation and grid-shift software, available via geodesy.noaa.gov.

Separately, NAD27 was itself superseded by NAD83, and the shift between the two is well documented to be non-uniform across the United States, on the order of tens of meters in places, which is why NOAA's National Geodetic Survey developed the NADCON grid-shift methodology rather than a single conversion formula. Any modern registration attempt that carries coordinates implied by these annotations forward to NAD83 or WGS84 without an explicit datum transformation will show residual error from this cause alone — a known, quantifiable effect, independent of whether the sheet itself is physically distorted.

6.2 Unknown: Historical Reference Frame and Annotation Function

The original 1876 geodetic reference system cannot presently be reconstructed from surviving documentation. NOAA's National Geodetic Survey, Remote Sensing Division, in correspondence dated July 29, 2026, clarified which marks on the surviving sheet belong to the original 1876 survey itself: survey control marks are represented by open triangle-and-circle symbols carrying station names in the sheet's original period hand. Three such named stations are visible on the surviving sheet: "High Table," "Ridge," and "La Mesa." "High Table" appears to correspond, in name and physiographic position, to the ridge Hancock's independent 1858 Rancho La Ballona survey labels "High rolling" / "Table Land" — a correspondence between two independent nineteenth-century surveys of this same ground.[9]

The five later annotations catalogued in Table 1 are a separate matter from these original station marks. Direct re-examination of higher-resolution scans permits, for the first time in this report's revision history, a more specific characterization of them than a single undifferentiated class. Three distinct sub-groups are now distinguishable:

- Three annotations (Table 1, Rows 1-3), rendered in blue ink as hatched triangles, each cite "North American (1927) Datum" together with "J.F.-33." Interpreted provisionally as surveyor initials followed by a two-digit year, this matches the standard station-recovery convention used on Coast and Geodetic Survey and National Geodetic Survey station histories, in which a visiting surveyor's initials and the year of a field visit are recorded together. Independent corroboration exists for active Coast and Geodetic Survey triangulation and topographic field work along this stretch of the Southern California coast in 1933-1934, though this report has not yet located a personnel record confirming surveyor initials "J.F." for that season.

[9]NOAA, National Ocean Service, National Geodetic Survey, Remote Sensing Division, email correspondence (Douglas Graham to this report's author), July 29, 2026 (on file), confirming that survey control marks on T-sheets are represented by the triangle symbols, citing "High Table," "Ridge," and "West Beach" as examples on this sheet, and noting that early topographers followed field procedures described in "The Plane-Table and Its Use in Topographical Surveying" (from the Coast Survey Report for 1865). This treatise is available at the Internet Archive: https://archive.org/details/planetable1865100harr/page/n19/mode/2up. The item is described there as a holograph manuscript in pencil and ink on lined paper, dated 1865, illustrated with sketched and printed diagrams and folded plates, and bound together with several printed excerpts: a proof copy apparently corresponding to a reprint of the treatise published as Appendix No. 22 in the Report of the Superintendent of the Coast Survey (1865, No. 30); an excerpt from the Providence Journal ("The Metrical System of France," by A. M. Harrison, dated November 30, 1869); projection tables from the 1853 Coast Survey report; the article "Telescopic Measurement in Surveying," by Benjamin Smith Lyman; and handwritten tables of triangulation. The Internet Archive's catalog record identifies the manuscript's author as A. M. (Alexander Medina) Harrison (1829-1881), the same person credited with the bound-in Providence Journal excerpt described above; this report's earlier drafts had understated this, having initially found only the bound excerpt's attribution and not the item-level catalog record. "High Table" corresponds, in name and physiographic position, to the ridge Hancock's 1858 Rancho La Ballona survey labels "High rolling" / "Table Land"; see this office's companion report, Botanical Notations in the 1858 Hancock and 1868 Hansen Rancho Surveys, Section V.1.

- One annotation (Table 1, Row 4), rendered in red or maroon ink as a hatched triangle, cites "North American datum" — without the "(1927)" qualifier — together with "H.B., 1913." The year 1913 corresponds precisely to the year Section 6.1 identifies as the date the U.S. Standard Datum was renamed the North American Datum, suggesting this annotation may record a contemporaneous, or near-contemporaneous, application of the datum's new name to this sheet.
- One annotation (Table 1, Row 5), rendered in graphite pencil as a cross rather than a triangle, cites "North American datum" together with a coordinate pair, but carries no surveyor initials and no year. This annotation sits at, or very near, the intersection of the sheet's own printed neatline graticule ticks. Its medium and its lack of attribution distinguish it from the other four; of the five annotations, it is the one most consistent in character with the graticule-tick-mark hypothesis discussed below.

None of these three candidate characterizations is presently confirmed against an independent record, and this report does not conclude that any is correct; they are offered as testable, better-specified alternatives to the single undifferentiated candidate explanation this report previously carried. Confirming any of them would require, at minimum, locating National Geodetic Survey Datasheet records for the named stations above showing 1913 and 1933 recovery history matching the initials transcribed here (see Section 8).

A specific, well-documented candidate explanation remains relevant, though now most plausibly to the graphite cross specifically rather than to all five annotations undifferentiated. In georeferencing 26 Southern California T-sheets, including T1432b, Grossinger et al. (2011) used projected and transformed North American Datum of 1927 latitude/longitude graticules — tick marks spaced at one-minute intervals on the original sheets — as their primary control method, reporting this approach as repeatable and productive of a consistent georectification. This report does not conclude that the graphite cross is the mark used in that specific study, or was placed for the same purpose; the correspondence is noted here as a documented, testable candidate explanation for future examination (see Section 8), not as an established finding.

6.3 Unknown: Non-Rigid Sheet Deformation

The surviving map may contain localized distortion introduced through paper aging (including humidity-induced dimensional change), printing, storage, handling, photographic reproduction, or digital scanning. Such effects would prevent perfect affine registration even if the original survey were internally accurate, and are independent of the datum-succession effect described in Section 6.1.

Direct physical examination of the surviving sheet offers physical, rather than purely hypothetical, support for this category of uncertainty. The original is mounted on a linen or muslin cloth backing, a common period practice intended to improve a topographic sheet's durability and dimensional stability in field and archival use. At the sheet's edges, this cloth backing is visibly exposed, frayed, and in places separated from the paper or vellum drafting surface. Differential dimensional response between a paper or vellum face and its cloth backing, through humidity cycling, handling, or age, is a well-documented conservation-literature behavior of linen-backed drafting media generally, and this observation identifies a plausible, directly observed physical mechanism for the kind of non-rigid distortion this section addresses, rather than a purely speculative one. This report does not attempt

to quantify the resulting distortion or its spatial distribution across the sheet from this observation alone.

6.4 Historical Compilation Methods

Different landscape elements may have been mapped using different field techniques. Coastlines and prominent topographic features may have received greater geometric control than marsh interiors. This distinction is consistent with historical Coast Survey practice and implies that the marsh interior should be treated as having lower, and less uniform, positional certainty than coastal and topographic features.

7. Implications for Ballona Wetlands Reconstruction

The principal implication is not that the wetlands shown on T1432b are incorrect. Rather, it is that their absolute position within a modern coordinate system cannot presently be established with complete confidence.

The map therefore remains an exceptionally valuable historical record of:

- wetland extent,
- channel morphology,[10]
- landscape organization,
- and coastal relationships.

However, precise engineering-scale positioning of interior marsh features should recognize the possibility of unquantified positional uncertainty resulting from the limitations discussed above.

Every derivative GIS layer, rectified image, or analytical product ultimately inherits these underlying geometric and documentary uncertainties because they originate in the surviving historical record itself rather than in subsequent digital processing. This is not hypothetical: T1432b has already served as a georeferenced base layer for at least one published historical-ecology reconstruction, in which digitized coastal features from T1432b were overlaid on modern aerial photography (Grossinger et al. 2011), and the sheet is potentially available through NOAA's own georeferencing tool (Section 5); the sources of positional uncertainty discussed in this report have therefore already propagated into at least one work product in current use. This applies with particular force to any lower-resolution derivative of this scan already in use for planning or regulatory purposes, since resolution loss can only compound, not resolve, the uncertainties documented here.

This is not hypothetical: this same uncertainty has already surfaced in independent field use of a T1432b-derived product. In attempting to relate a documented nineteenth-century boundary-survey tree location to the willow-thicket habitat polygon Grossinger et al. (2011) digitized from T1432b, a wetlands researcher familiar with the site's vegetation history sought to determine whether the two coincided. That question cannot presently be answered, for the same reason this report documents

[10]This report uses the neutral term "channel morphology" rather than "tidal channel morphology" because the historical condition of the lagoon entrance is a distinct question, addressed at length in this office's dedicated Ballona historical-hydrology reports, and is not necessary to the geometric-uncertainty analysis presented here. As a single, contemporaneous anchor consistent with that broader body of work: in his own field notes (Remarks, July 19–23, 1858), recorded under the same sworn commission as his survey oath, Hancock described the inner bay's connection with the sea as "often obstructed." This report does not develop that evidentiary question further here; see this office's other Ballona historical-hydrology reports for the full documentary record.

throughout: the historical tree's position is known only relative to its own independent nineteenth-century survey record, while the habitat polygon's position depends on T1432b's own unresolved annotation function and datum lineage (Sections 6.1-6.2).

Two independently well-documented historical records — a boundary survey and a habitat reconstruction — cannot presently be reconciled to a common modern coordinate system, not because either record is flawed, but because the intermediate step of georeferencing T1432b itself carries the uncertainties this report describes.

8. Future Research

Several questions remain unresolved.

- Search the NGS Integrated Database / NGS Data Explorer for historical triangulation stations named "High Table," "Ridge," "La Mesa," "West Beach," and "Centinela," and examine each station's recovery history for entries matching the confirmed transcriptions "J.F." in 1933 and "H.B." in 1913, to determine whether these annotations correspond to documented, independently recoverable station-visit records, or instead represent plotted coordinates or later registration control with no independent station record.
- Compare T1432b with adjoining contemporary T-Sheets to evaluate consistency across survey boundaries.
- Quantify registration residuals using affine, polynomial, and thin-plate spline transformations.
- Determine whether residual errors are uniformly distributed or concentrated within the marsh region.
- Establish an uncertainty envelope describing the probable positional accuracy of marsh features; as an empirical reference point, Grossinger et al. (2011) report an average measured error of 19.28 m for their method of georeferencing NAD 1927 latitude/longitude graticule tick marks (spaced at one-minute intervals) forward to NAD83, describing the result as "generally within 20 m" and, in some cases, "within 10-15 m," while cautioning that such T-sheets "should not be assumed to have a potential error of less than 50 m."
- Test whether the five annotations are consistent with NAD 1927 latitude/longitude graticule intersections spaced at one-minute intervals — the method used by Grossinger et al. (2011) for comparable T-sheets — which would provide a specific, testable function for these marks distinct from triangulation station recovery.
- Determine whether T1432b is among the approximately 7,800 shoreline surveys georeferenced in NOAA's Historical Shoreline Survey Viewer; if so, evaluate the accuracy of NOAA's own world file as an independent registration attempt.
- Determine whether the five annotations represent a minimum control network selected during a later historical georeferencing effort, rather than original Coast and Geodetic Survey control established at the time of the 1876 survey.
- The two previously unresolved transcription elements identified in Table 1 (Footnote 2) have since been resolved through direct examination of higher-resolution scans (Section 6.2); confirm these readings ("J.F.-33," "H.B., 1913") against an original, in-person examination of

the sheet when practicable, as a final check on the higher-resolution scan-based transcriptions.

- Compare the 1876 Chase survey with the 1887 Westdahl resurvey (Section 5) to quantify mapped changes associated with dredging and jetty construction at the channel mouth, and determine whether the later survey provides additional geodetic control or registration constraints distinct from the annotations addressed elsewhere in this report.

Conclusions

T1432b should not be regarded simply as a historical map requiring a datum conversion. Instead, it represents a more complex historical geospatial reconstruction problem involving incomplete archival documentation, nineteenth-century marsh surveying practices, later geodetic reference annotations of uncertain function, a well-documented but separate datum-succession effect, and possible non-rigid deformation of the surviving sheet.

NOAA has confirmed that no Descriptive Report was prepared for this survey because such documentation was not yet required in 1876. Historical Coast Survey guidance further indicates that marshes were often mapped with greater interpretive flexibility than more easily measured terrain, and that differences between adjoining marsh surveys were recognized even during the nineteenth century.

Accordingly, T1432b remains an indispensable historical record of the Ballona landscape, but its use in modern geospatial analysis should explicitly acknowledge the uncertainty associated with its original survey framework, its later annotations, and its subsequent registration. The appropriate scientific conclusion is not that the wetlands are demonstrably distorted, but that their modern spatial position cannot presently be reconstructed uniquely from the surviving documentary and cartographic evidence.

References

The footnotes throughout this report combine citation with explanatory discussion. The list below consolidates full bibliographic detail for every source cited, in order of first appearance, for the convenience of future researchers.

[1] Field Notes of the Final Survey of the Rancho La Ballona, Agustin Machado et al., Confirmee. Henry Hancock, Deputy Surveyor. Survey commenced July 14, 1858; completed July 19, 1858. County Surveyor Volume G5, pages 298-314. Certified as a true transcript by Theo. Wagner, U.S. Surveyor-General for California, San Francisco, February 17, 1882.

[2] NOAA, National Ocean Service, Office of Coast Survey, Remote Sensing Division. Email correspondence with this report's author, April 20, 2021. On file.

[3] NOAA, National Ocean Service, National Geodetic Survey Information Center. Email correspondence with this report's author, April 9, 2021. On file.

[4] NOAA, National Ocean Service, National Geodetic Survey, Remote Sensing Division (Douglas Graham). Email correspondence with this report's author, July 29, 2026. On file.

[5] NOAA Office of Coast Survey. "Historical Surveys (T-Sheets)." https://shoreline.noaa.gov/data/datasheets/t-sheets.html. Accessed 2026.

[6] National Geodetic Survey. "Datums and Reference Frames." https://geodesy.noaa.gov/datums/index.shtml.

[7] National Geodetic Survey. "NADCON - North American Datum Conversion Utility." https://geodesy.noaa.gov/TOOLS/Nadcon/Nadcon.shtml.

[8] Shalowitz, A. L. Shore and Sea Boundaries, Volume Two: Interpretation and Use of Coast and Geodetic Survey Data. U.S. Coast and Geodetic Survey Publication 10-1. Washington, D.C.: U.S. Government Printing Office, 1964.

[9] Grossinger, R. M., E. D. Stein, K. N. Cayce, R. A. Askevold, S. Dark, and A. A. Whipple. 2011. Historical Wetlands of the Southern California Coast: An Atlas of US Coast Survey T-sheets, 1851-1889. San Francisco Estuary Institute Contribution #586 / Southern California Coastal Water Research Project Technical Report #589. T1432b is discussed at pp. 20-23; Figure 18 (p. 23) is captioned "Coastal features digitized from T-1432b, overlaid on modern aerial photography (USDA 2005), at same scale as facing T-sheet"; the Westdahl 1887 resurvey discussion appears on p. 20.

[10] Harrison, A. M. (Alexander Medina), 1829-1881. "The Plane-Table and Its Use in Topographical Surveying" (cataloged by the holding institution as "The Plane Table 1865-1869"; apparently corresponding to Appendix No. 22, Report of the Superintendent of the Coast Survey, 1865, No. 30). Holograph manuscript in pencil and ink, dated 1865, with bound printed excerpts (see references 11-12 below). Internet Archive: https://archive.org/details/planetable1865100harr/page/n19/mode/2up.

[11] Harrison, A. M. "The Metrical System of France." Providence Journal, November 30, 1869. Bound excerpt within reference [10], by the same author.

[12] Lyman, Benjamin Smith. "Telescopic Measurement in Surveying." Bound excerpt within reference [10]; original publication details not independently verified beyond the Internet Archive record.

[13] This office's companion report, Botanical Notations in the 1858 Hancock and 1868 Hansen Rancho Surveys, cited in Footnote 9 regarding the correspondence between "High Table" and Hancock's "High rolling Table Land."

Appendix A: Annotated Sheet Overview

Figure 1 shows the full extent of T1432b with the five later geodetic reference annotations discussed in Table 1 circled for reference. Figure 2 shows the same sheet with the two general areas discussed in this report's analysis — the western marsh and the coastal marsh fronting Santa Monica Bay — labeled “Region of Interest” as a working reference used during the preparation of this report. These labels are the authors' own working annotations, not part of the original 1876 survey, and are retained here for reader orientation only; they do not represent a boundary, finding, or determination of any kind.

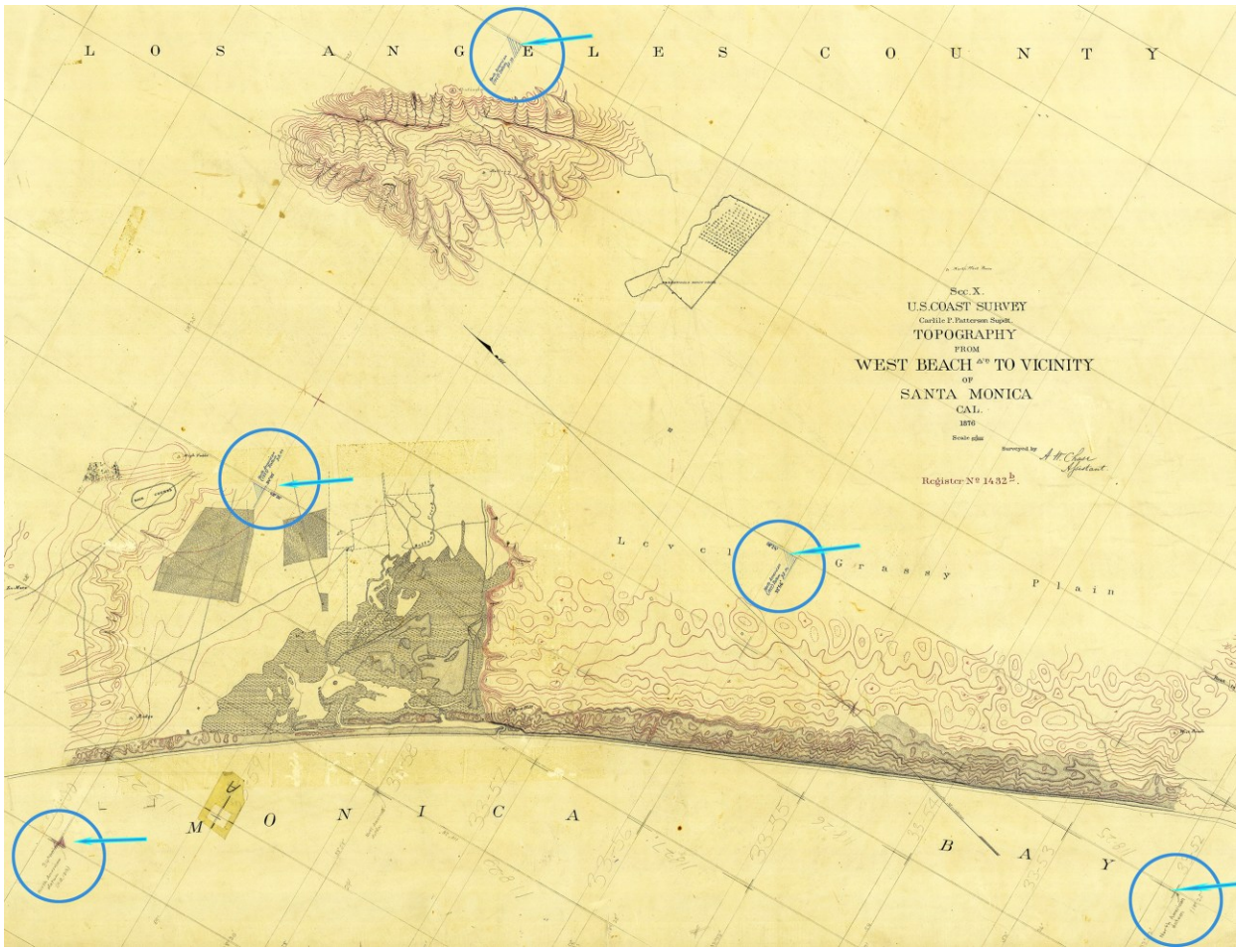

Figure 1. T1432b with the five later geodetic reference annotations circled (see Table 1).

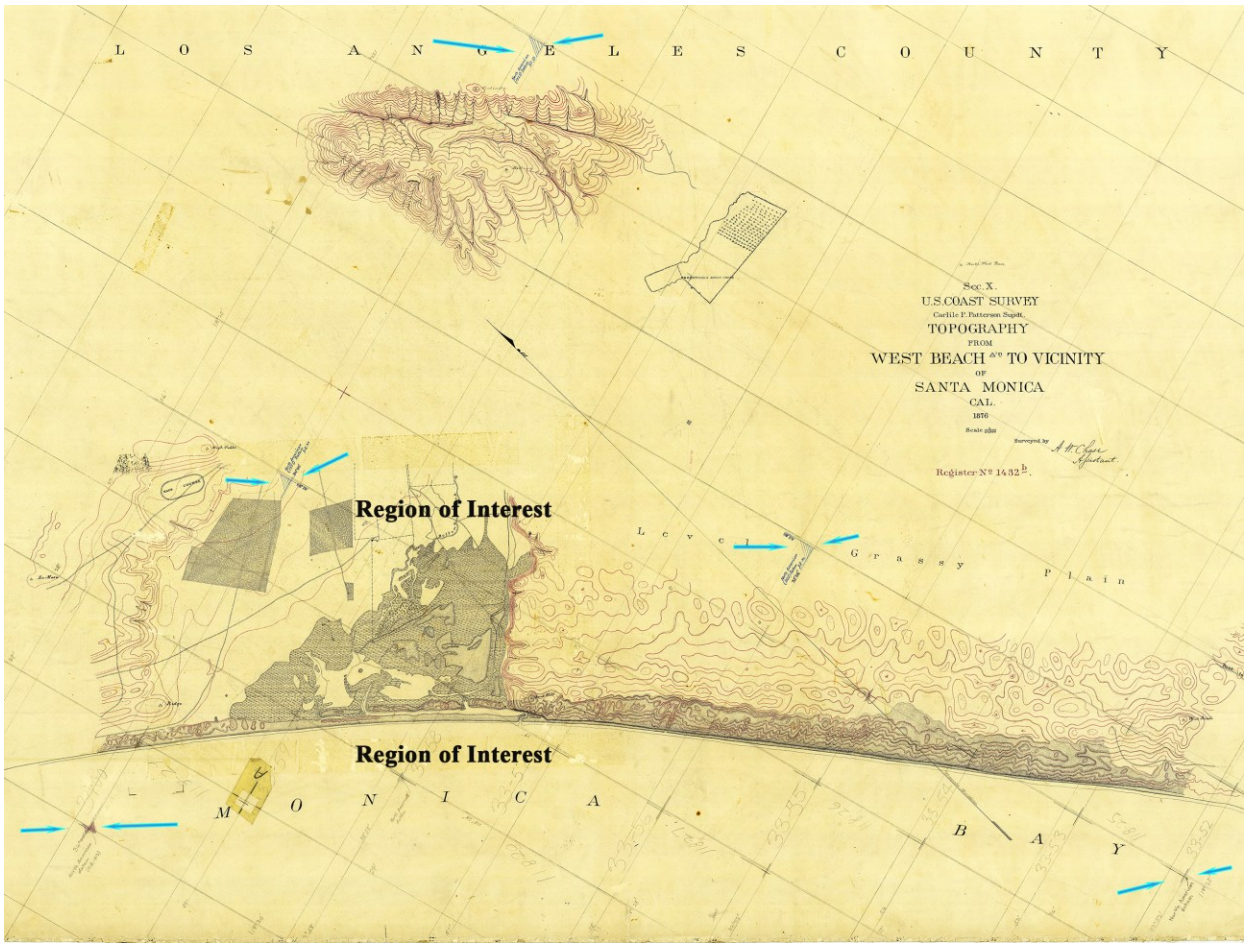

Figure 2. T1432b with the five annotations and the two working "Region of Interest" areas labeled for reader orientation (authors' working annotation, not part of the original survey).

Figures 3 and 4 present two candidate ways of illustrating a single example annotation for readers unfamiliar with the sheet: Figure 3 shows the annotation in its surrounding context, alongside two of the original 1876 named survey control marks discussed in Section 6.2; Figure 4 shows a close, legible detail of the same annotation's "J.F.-33" notation alone. Both are included here, pending review, so that this report's reviewers can assess which better serves a reader encountering this material for the first time.

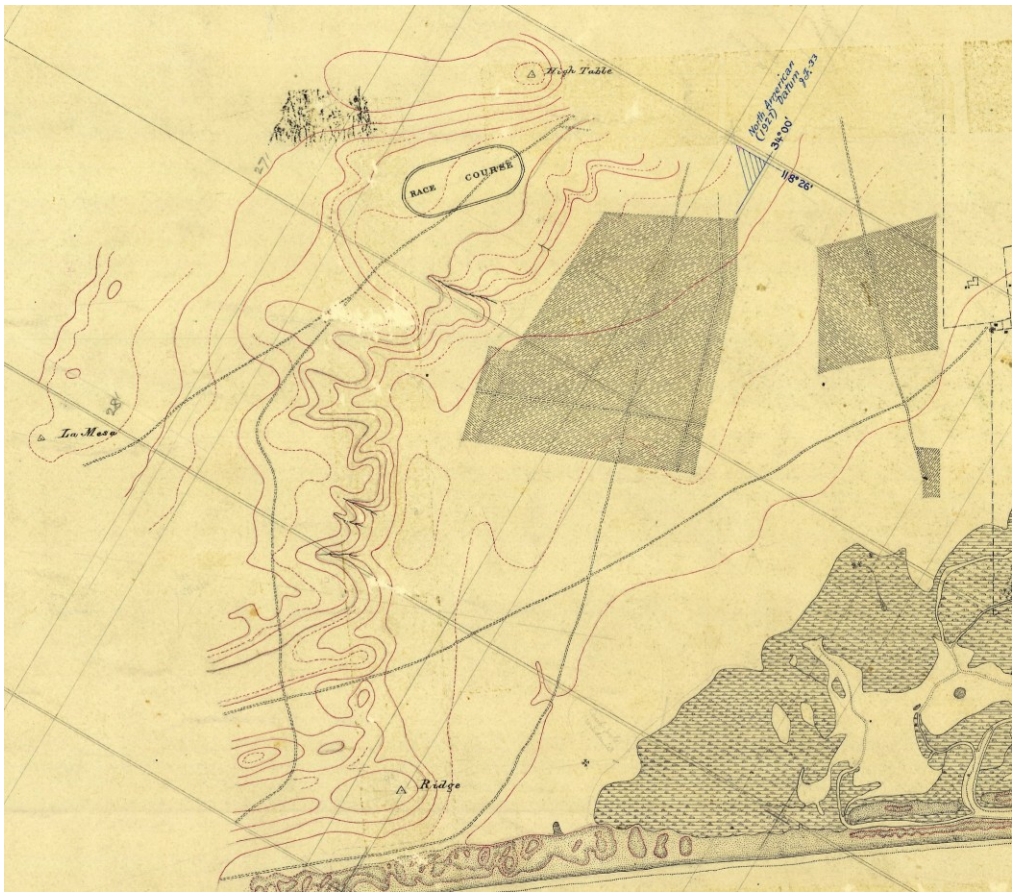

Figure 3. Candidate A. T1432b detail (tightly cropped for focus) showing three of the original 1876 named survey control marks discussed in Section 6.2 — "High Table," "La Mesa," and "Ridge" (open triangle-and-circle symbols, period hand) — together with a later "North American (1927) Datum," "J.F.-33" annotation (blue hatched triangle) positioned nearest to "High Table," corresponding to Table 1, Row 2.

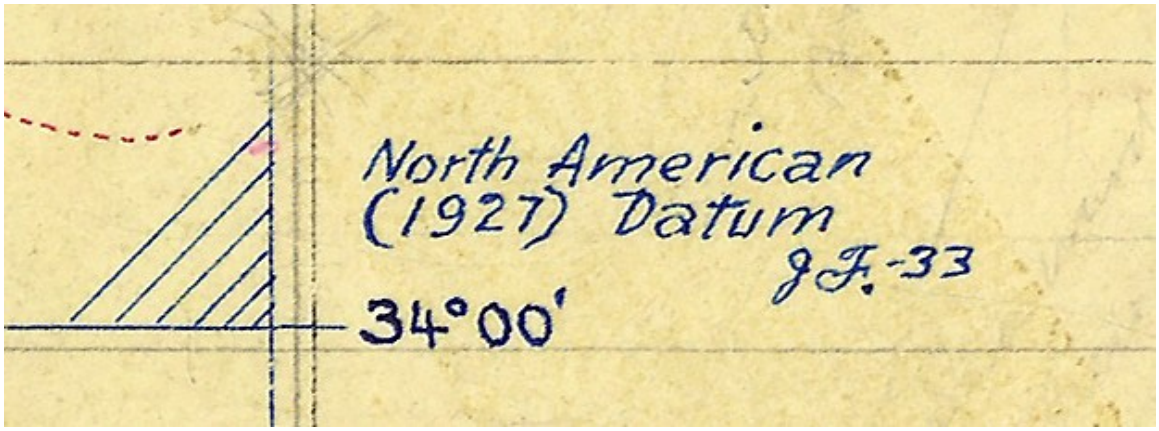

Figure 4. Candidate B. Close detail of the same annotation's "North American (1927) Datum," "J.F.-33," "34°00'" notation, shown at higher magnification for legibility.